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PSYCHOPHYSIOLOGICAL MECHANISMS OF STRESS RESPONSIVITY

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INTRODUCTION

This report will briefly summarize the work in four areas which have been investigated by this laboratory on contract AF 49 (638) - 354.

1. Central nervous system, peripheral physiological endocrinological and psychological responses of body and field oriented subjects to experimental situations characterized by uncertainty, social and sensory isolation and limitation of movement.

2. Analysis of personality, physiological and central nervous system correlates of body and field perceptual modes and the exploration of other individual determinants of the response to low sensory input experiments.

3. A study of the influence of drugs acting on central nervous system in body and field oriented subjects in low sensory input experiments.

4. An exploratory study of the influence of a psychochemical (LSD) on [illegible] response to two hour low sensory input experimental conditions.

The investigators wish to express their deep appreciation to Lt. Col. Duncan, Captain Powell and the staff of the Duke Air Force ROTC for their cooperation with the Laboratory in carrying out these studies. The investigators are particularly grateful to the students, for their continued participation as volunteers in these experiments.

I. BODY-FIELD PERCEPTUAL DIMENSION AND THE RESPONSE TO LOW SENSORY INPUT EXPERIMENT

This study was designed to extend some of the limited observations now available on the endocrinological and physiological changes which occur in controlled low sensory input situations. There have been reports of the psychological impact of isolation and sensory deprivation environments but there have been only a few studies of the effects of altered sensory environments on the activity of the central nervous system and its physiological and endocrinological correlates.

In addition, most of the previous sensory deprivation experiments and experiences, in which psychological effects have been noted, have been long in duration and very arduous experiences, while the interest in this study was to determine if a short (2 hour) period of low sensory input would be effective in producing similar effects.

Individuals were shown by Witkin and others to vary in the relative extent they depended on external visual cues and in their relative ability to utilize body or proprioceptive experiences in perceiving spatial relations. This investigation was also an attempt to broaden Witkin's observations by establishing whether characteristic perceptual orientations (and their personality correlates) were associated with any differences in psychological, central and autonomic nervous system, endocrinological or peripheral physiological response to low sensory input experiments.

Thirty-five male subjects without evidence of overt psychopathological or psychophysiological disorders were tested for two hours in an experimental situation in which there was a reduction of visual and auditory input and the creation of a state of uncertainty by leaving the subjects in dark soundproof room without information

about the nature of experiment. The experimental "environment" was expected to highlight perceptual mode differences (body and field oriented) determined by Rod and Frame and Draw-A-Person tests and personality differences established on the basis of an extensive "pre-stress" test battery.

The subjects were evaluated by pre and post-experimental tests of sensory discrimination (touch threshold and pain tolerance), measures of emotional, cognitive and perceptual functions, urinary assays for adrenaline and noradrenaline and by continuous bioelectrical measures of central nervous system arousal (G. S. R. and E. E. G.) and cardiovascular and respiratory activity. (Figure 1).

No specific effect could be attributed to exposure to the experimental conditions for any one measure. When total subject population was considered the experimental environment did not produce any uniform effects and their responses appeared to show a random distribution of psychological and physiological responses. For example, some subjects showed: 1) a reduction in central nervous system activity (skin resistance and E. E. G.) and others an increase; 2) an increase or a decrease in the accuracy of sensory integrative functions in the threshold to tactile stimuli and pain tolerance levels; 3) high or low level of psychological discomfort; 4) a predominately anxious or a predominately angry emotional state. (Table 1)

When subject population was studied in terms of specific personality and perceptual dimensions as evaluated from pre-experimental testing, the specific subgroups did not demonstrate a random distribution of responses for the psychological and physiological variables assessed during the experiment.

Subjects who were field oriented and who had the highest Taylor Anxiety scores showed in contrast, to other subject: 1) most intense psychological discomfort (4 of

the 5 subjects who requested the experiment be terminated were field subjects); 2) greater evidence of anxious rather than angry emotional states; 3) more suspiciousness; 4) higher incidence of visual and auditory imagery; 5) more evidence of disorganization of thought; 6) greater discomfort with body sensations, inner feelings and fantasies; 7) moved and talked more during the experiment.

In addition to the differences in psychological responses, body and field subjects showed differences in physiological, endocrinological and neurological measures which suggested a possible difference in central nervous system functioning in the 2 groups.

The field oriented subjects revealed:

1. Less of an ability to discriminate somato sensory cues which was most pronounced after the two-hour experiment. (Figure 2)

2. E.E.G. and skin resistance evidence of a higher level of cortical alerting and peripheral autonomic activation during the experiment although both groups started at the same level of activity. (Figure 3, 4 and 5)

3. A trend was noted which suggested that the mean resting and mean post-stress adrenaline and noradrenaline levels of the field oriented subjects were lower in spite of the fact that the field subjects had a higher level of central nervous system activation. In another study, a group of ulcer patients were found to have psychologic characteristics similar to those described for field oriented persons. The ulcer patients had lower noradrenaline levels during a rest period and after injections of insulin than a group of control subjects with psychological characteristics similar to body oriented subjects. The possible relationship of noradrenaline levels during rest and after exposure to an arousing situation to an individual's perceptual orienta-

tion will have to be explored in further studies. It may be that individual neurophysiological or neurohumoral differences may be associated with differences in perceptual mode (i.e., a body or field orientation).

4. The data suggested that there was a much greater degree of pulse variability in the body than in the field group. This finding may be related to Lacey's work in which he describes a group of cardiac "labiles" who show considerable variation in cardiac rate. The description Lacey gives of these subjects in terms of their perceptual characteristics is very reminiscent of a body oriented perceptual mode. S. Fisher reported a correlation between pulse variability and body boundary scores on Rorschach. Subjects with high body boundary scores were similar to body oriented subjects on the basis of psychological test characteristics.

The relationships between some of the experimental measures were studied in an attempt to understand the interactions between psychological, neurophysiological, peripheral physiological and endocrinological variables. (Figure 6)

A high level of psychological discomfort (4+) was accompanied by either a high post-experimental adrenaline urinary level (mean of 1.21 micrograms for 4+ group) and/or an increase in peripheral sympathetic nervous system activity as reflected in the G.S.R. (mean change in nonspecific fluctuations in subjects rated 4+ was +3.4 from first to last five minutes). Subjects with low levels of psychological discomfort (1+) had low post-stress adrenaline levels (mean for subjects rated it was 0.45 microgram/hour) and a decrease in sympathetic nervous system activity during the experiment (mean change of -17 in nonspecific fluctuations from first to last five minutes). The mean differences of subjects rated 1+ and 4+ was significant at .05 level.

The total number of alpha deflections on the peripheral plethysmograph was taken as a reflection of the number of changes in blood volume and vascular tone of the subjects. (Figure 7). When the relationship of G.S.R., adrenaline and peripheral vascular activity was reviewed, it appeared that the group of subjects with the largest mean number of alpha deflections (mean total of 120 or more deflections) had the largest number of nonspecific G.S.R. fluctuations (total mean of over 100) and the highest post-experimental adrenaline levels (1.6 micrograms and over). Total number and change in number of alpha deflections on plethysmograph correlated significantly with total number and change in number of nonspecific G.S.R. The number and change in plethysmograph waves and the post-experimental adrenaline levels also were significantly correlated.

There was no correlation between peripheral vascular activity and noradrenaline levels or changes in adrenaline or noradrenaline levels.

However, a few subjects who had over 100 G.S.R. fluctuations and a few subjects who had adrenaline levels over 1.6 micrograms did not have a high level of vascular activity (over 120 alpha fluctuations). This indicated that adrenaline output as assessed in urine and autonomic activity as assessed by skin resistance changes are not the sole determinants of alpha plethysmographic deflections. In addition, it also suggests that the measures used are not necessarily precise and can only be used to suggest, rather than accurately identify, vascular autonomic endocrine relationships.

Hence, it appeared that a high adrenaline level or a high level of nonspecific G.S.R.'s (together or separately) are accompanied by a high degree of peripheral vascular activity. Low levels of autonomic activity and low adrenaline levels

occurring in the same subject are usually associated with a low level of peripheral vascular activity.

The degree of psychological discomfort exhibited by the subject regardless of the qualitative nature of that discomfort or the factors leading to the discomfort might be the parameter best considered as reflecting the psychologic stress response of the subject. Hypothetically, this degree of psychologic discomfort should be reflected in the change in central nervous system activity or arousal, as well as, a change in overt motor behavior (Note Figure 6). The change in central nervous system arousal might then lead to a change in the level of activity of humoral or peripheral autonomic functions: For example, an increase in central nervous system arousal might lead to an increase in peripheral autonomic activity and/or increase in endogenous adrenaline release as suggested by the data. Furthermore, the increase in peripheral autonomic activity or the increase in endogenous adrenaline release might then affect the peripheral vascular system. It is well to remember that the peripheral vessels (more specifically the vessels of the finger) are in a sense self limited in the degree of activity they can demonstrate (That is to say, once the vessel is constricted further influences which can lead to vasoconstriction will cause no change in the vessel tone or the finger volume as a result of changes in the vessel tone). The ultimate state of the peripheral vascular system is not felt to be particularly dependent on the change in the level of humoral or peripheral autonomic activity but is believed to be more dependent upon the amount of autonomic or humoral activity over a period of time. On the other hand, a transient burst of peripheral autonomic activity or the sudden release of humoral substances in a subject whose peripheral vessels are not

maximally constricted can lead to a vasoconstrictive "episode" and a shift in blood volume.

The data described in this section suggests that the type of psychological changes noted in the subjects were the result of an interaction of individual subject variables (e.g., body and field orientation) and environmental variables (e.g. uncertainty, low sensory input) and that the physiological responses are determined by an interaction of several factors such as physical environmental conditions, "psychological" arousal, changes in central and peripheral nervous system activity, endocrinological changes and alterations in the other physiological systems. It is important also to keep in mind that "alerting" of an organism can result in facilitation of the activity of some physiological systems and inhibitions in others.

In considering the cortical alerting as measured by the EEG and autonomic arousal as assessed by G.S.R activity, evidence was presented which suggested maintenance of greater "arousal" in the field than in the body and middle group. This was not apparently related to the initial state or individual physiological differences at the onset of the experiment. With time, however, the groups became bioelectrically differentiated, suggesting that these results were associated with their differential "coping" with the situation.

When various psychological responses were grouped to obtain a rough Ego Function Index, field subjects showed a greater degree of disorganization. In addition, there was a correlation of this gross Ego Organization and the subjects' ability to organize and integrate sensory data.

Although body oriented subjects focused attention on themselves, this was not to the exclusion of the environment. There was, in essence, an attempt to scan, explore, and understand the environment. In reviewing the field oriented subjects, the subjects who showed the best balance in their focus between attention to environmental stimuli and attention to stimuli related to the self, showed the least evidence of ego breakdown.

The study described in this section has, suggested that there are differences in the stress inducing nature of an environment containing the elements of social and sensory isolation, immobility and uncertainty on person with different perceptual orientations on a body and field continuum.

If one were interested in predicting the "effectiveness" with which an individual could carry out some function in a physically and psychologically stressful environment, it would seem essential to study at least three areas: 1) the "environmental" variables (conditions to which the person would be exposed); 2) "individual" variables which might be important determinants of the response to the environmental condition; 3) the specific response variables which were related to the individual's over all ability to "function".

It would appear then that predictions regarding some of the psychophysiological changes which have been focused on in this paper would have to be based on a knowledge of the system being measured and the influence of changes in other systems upon it, as well as the type of environmental "stresses" and the characteristics of the individual who is exposed to the "stress".

FIGURE 1

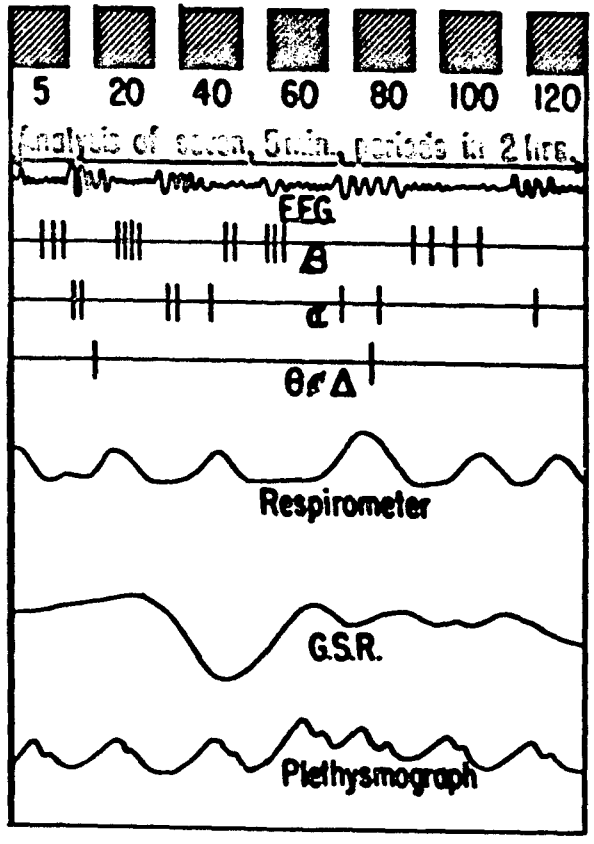
This figure outlines the experimental design of the two hour low sensory input experiment.

SENSORY DEPRIVATION EXPERIMENT

PRE-ISOLATION

1. PSYCHOLOGIC TESTING
   - ROD AND FRAME
   - RORSHACH
   - M.M.P.I.
   - INTERPERSONAL CHECK LIST
   - EDWARDS PERSONAL PREFERENCE
   - PERSONAL HISTORY
   - CHARACTEROLOGIC QUESTIONNAIRE
   - DRAW-A-PERSON
2. CATECHOL AMINES
   STEROIDS
3. NEUROLOGIC TESTING
   - LETTER IDENTIFICATION
   - 2 POINT DISCRIMINATION
   - TOUCH AND PAIN THRESHOLD

CHAMBER TIME



POST-ISOLATION

1. SINGLE QUESTION INTERVIEW
2. NEUROLOGIC TESTING
   - LETTER IDENTIFICATION
   - 2 POINT DISCRIMINATION
   - TOUCH AND PAIN THRESHOLD
3. FOCUSSED INTERVIEW USING STANDARD PROTOCOL
4. CATECHOL AMINES
   STEROIDS
5. FOOD
6. OPEN-END QUESTIONNAIRES FOCUSSED ON SAME AREAS AS IN THE CHAMBER INTERVIEW

TABLE 1

The responses of the total subject population are summarized on this table.

SUMMARY OF RESPONSES

Measure	Increase (number of subjects)	No Change (number of subjects)	Decrease (number of subjects)	Comment
E.E.G. activity	12	0	19	Decrease (trend)
G.S.R. activity	9	1	23	Decrease
Pulse rate	5	1	26	Decrease
Plethysmograph fluctuations	14	4	13	Random
Adrenaline	14	1	14	Random
Noradrenaline	12	0	18	Decrease (trend)
Somato-sensory discrimination	11	5	11	Random
	High (4+)	Mod. (2&3+)	Low (1+)	
Discomfort	10	16	9	Moderate predominates
Emotional state	Anxiety 14	Mixed 12	Anger 8	Trend to anxiety

FIGURE 2

The pre and post-experimental scores for accuracy with body and field subjects for somato-sensory neurological testing is summarized on this chart.

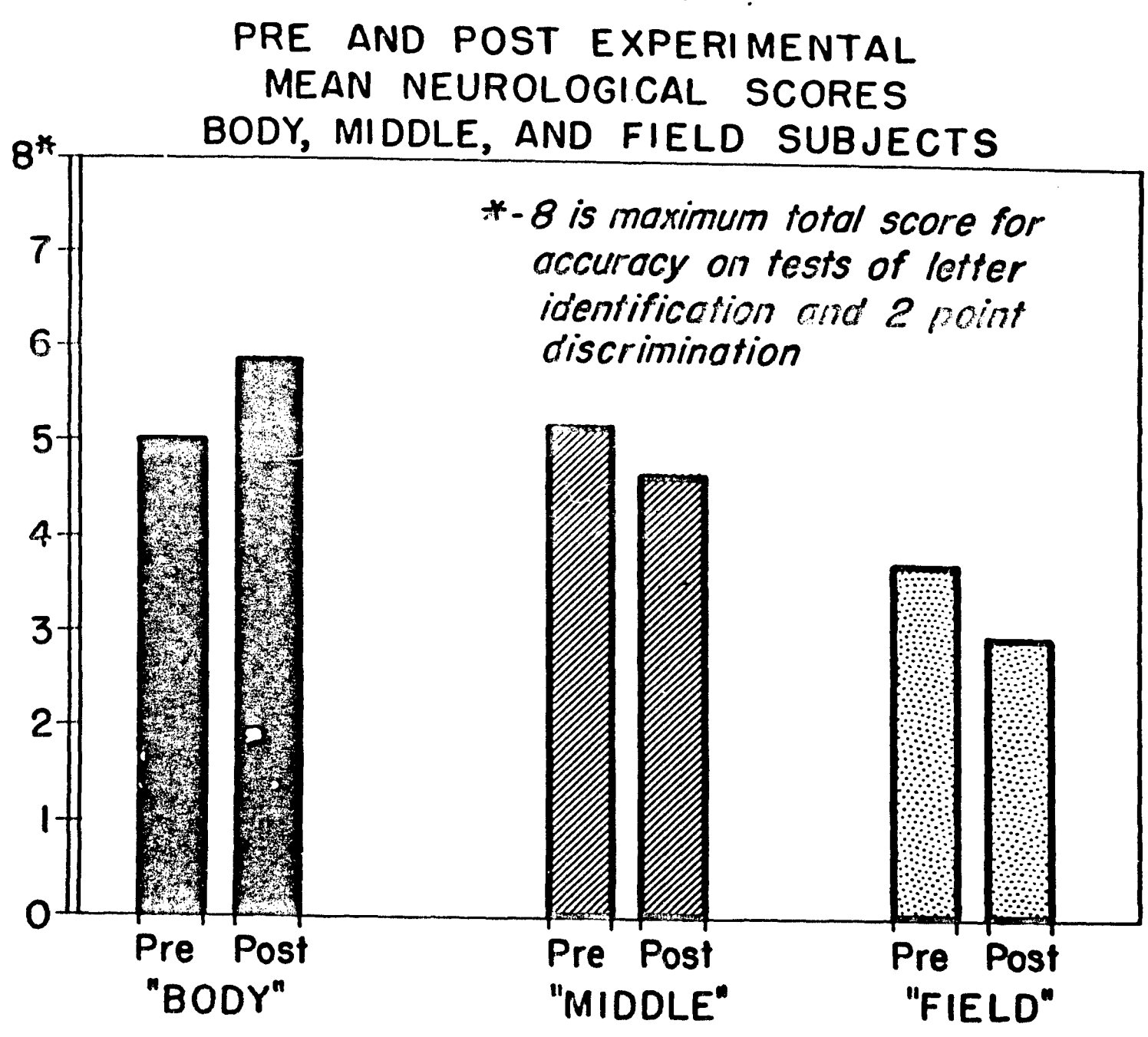

PRE AND POST EXPERIMENTAL
MEAN NEUROLOGICAL SCORES
BODY, MIDDLE, AND FIELD SUBJECTS
8*
7
6
5
4
3
2
1
0
*-8 is maximum total score for accuracy on tests of letter identification and 2 point discrimination
Pre
Post
"BODY"
Pre
Post
"MIDDLE"
Pre
Post
"FIELD"

FIGURE 3

This figure shows the change in the alpha waves count on the EEG (resting brain rhythm) during the two hour experiment.

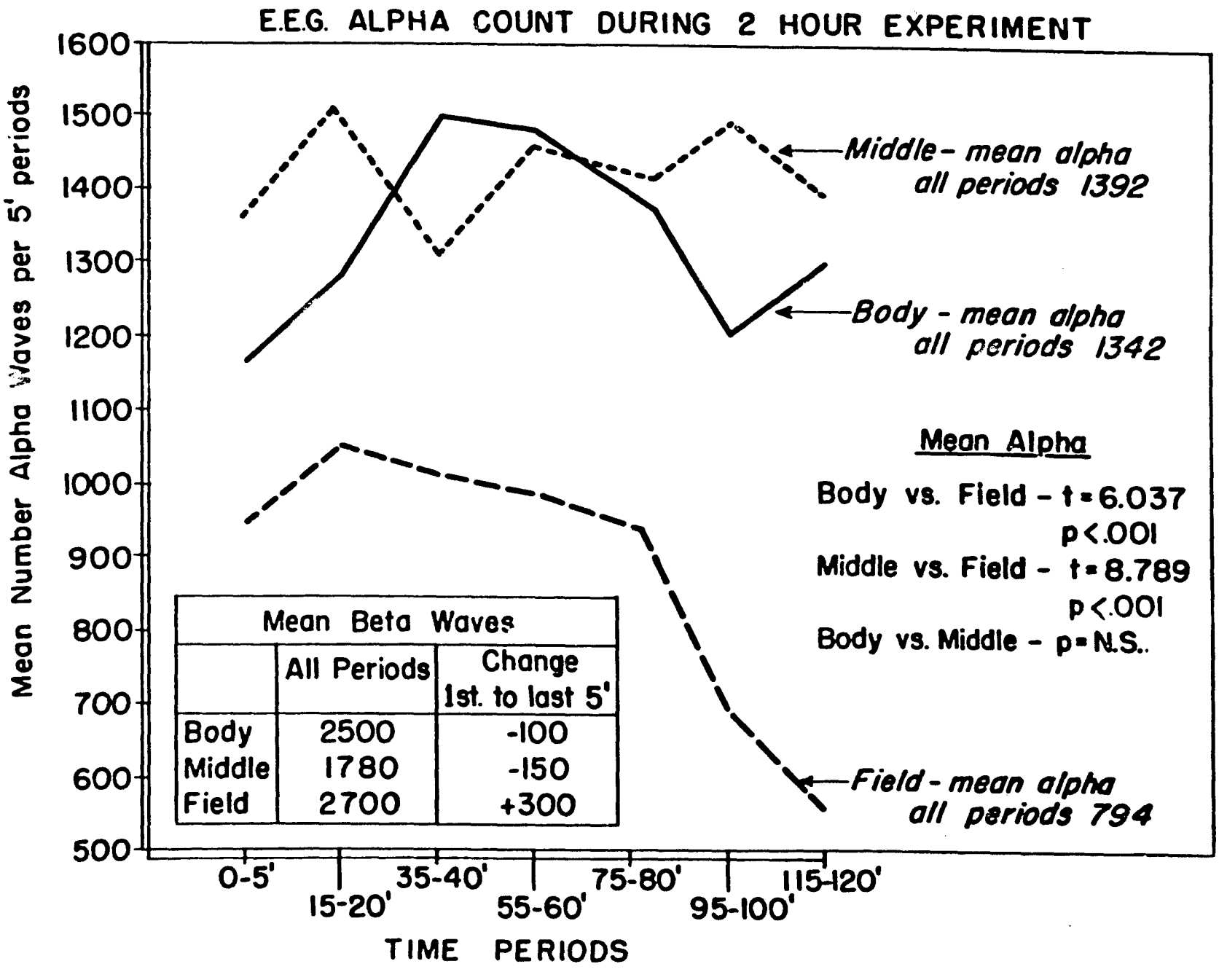

E.E.G. ALPHA COUNT DURING 2 HOUR EXPERIMENT
Mean Number Alpha Waves per 5' periods
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
Middle - mean alpha all periods 1392
Body - mean alpha all periods 1342
Field - mean alpha all periods 794
Mean Alpha
Body vs. Field - t = 6.037 p < .001
Middle vs. Field - t = 8.789 p < .001
Body vs. Middle - p = N.S..
Mean Beta Waves
All Periods
Change 1st. to last 5'
Body 2500 -100
Middle 1780 -150
Field 2700 +300
0-5'
15-20'
35-40'
55-60'
75-80'
95-100'
115-120'
TIME PERIODS

FIGURE 4

The mean number of nonspecific fluctuations in skin resistance during the two hour experiment in the three subject populations are shown on this chart.

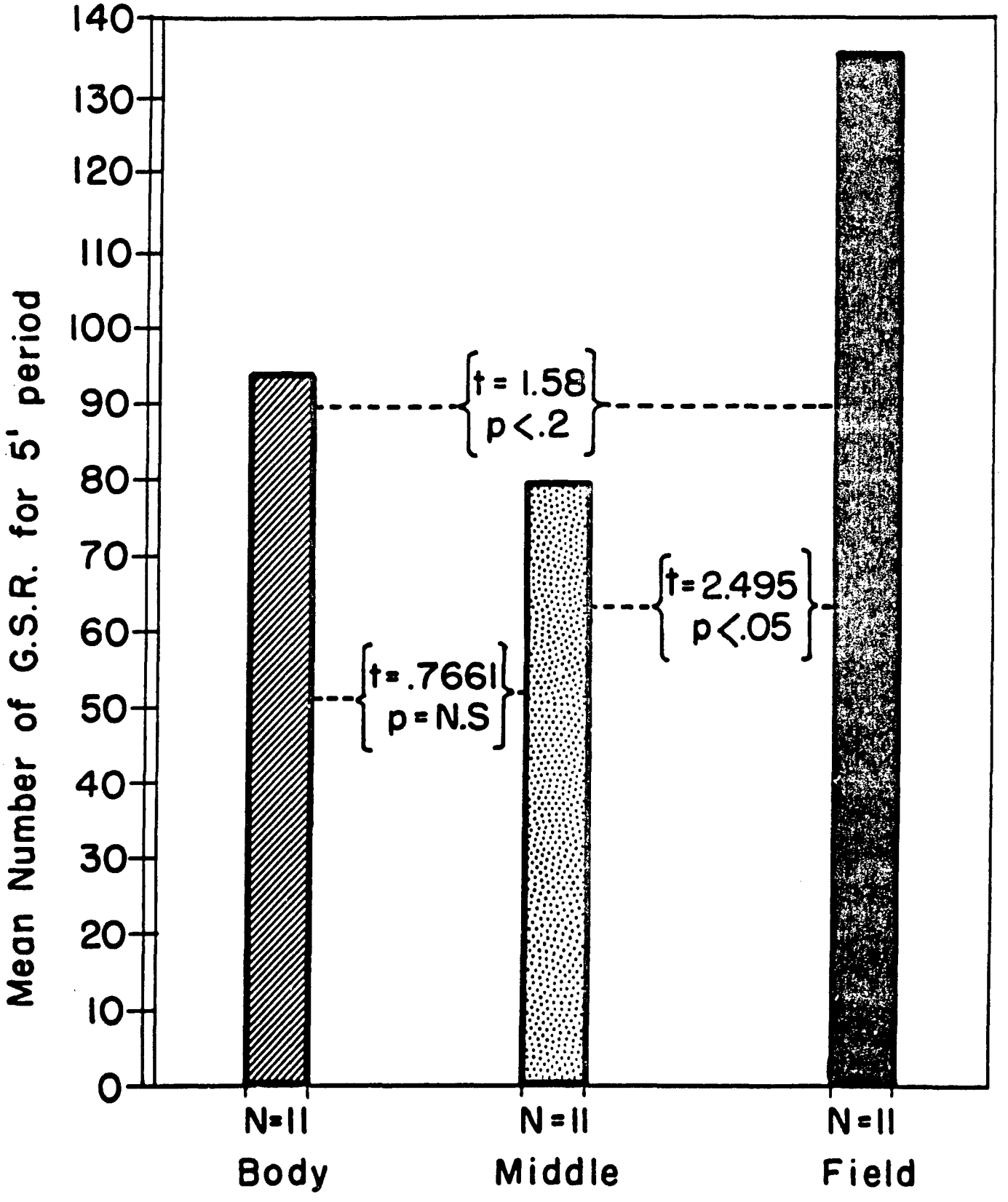
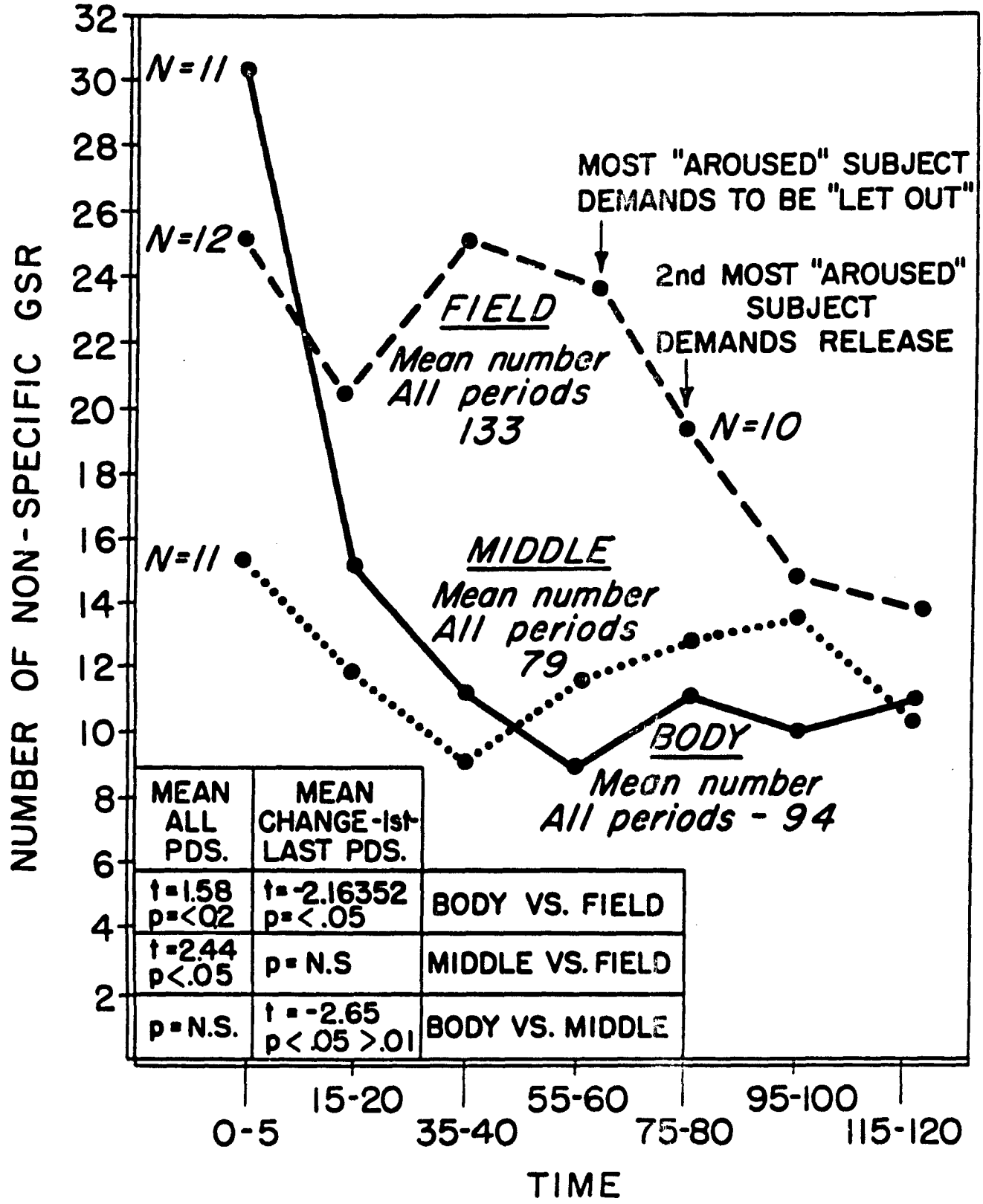

MEAN NUMBER OF NON-SPECIFIC G.S.R.
IN BODY AND FIELD SUBJECTS
Mean Number of G.S.R. for 5' period
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
t = 1.58
p < .2
t = .7661
p = N.S
t = 2.495
p < .05
N = 11
Body
N = 11
Middle
N = 11
Field

FIGURE 5

This figure shows the mean number of nonspecific skin resistance fluctuations for each of the seven five minute periods which were assessed during the two hour experiment.

MEAN NON-SPECIFIC GSR IN BODY AND FIELD SUBJECTS



MEAN ALL PDS.	MEAN CHANGE-1st-LAST PDS.	
t=1.58 p=<02	t=-2.16352 p=<.05	BODY VS. FIELD
t=2.44 p<.05	p=N.S	MIDDLE VS. FIELD
p=N.S.	t=-2.65 p<.05>.01	BODY VS. MIDDLE

FIGURE 6

This figure shows the relationship of post-experimental interview ratings of discomfort and the change in EEG and skin resistance activity from the onset to the end of the experiment, the post-experimental adrenaline levels and the total movement during the experiment.

The differences of 1+ and 4+group were all significant at better than .05 level (t-test).

CORRELATES OF DISCOMFORT

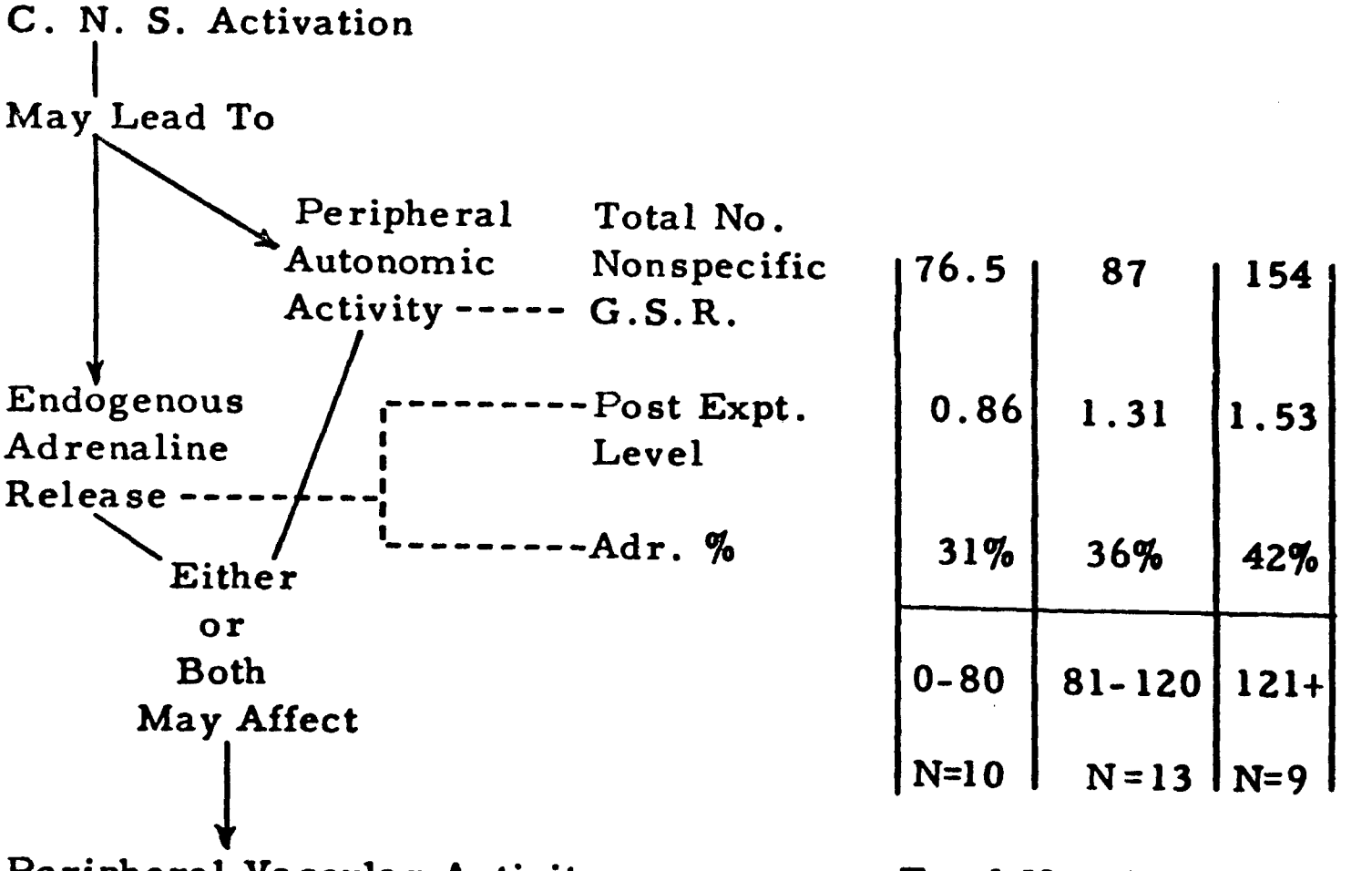
		4+ (High)	2-3+	1+ (Low)
Intensity of Discomfort	Interview Rating			
→ Behavior	Movement Artifact Time	22.8'	13.3'	14'
Cortical Activation	Change in EEG 1st to last 5'			
→ Change in Peripheral Autonomic Activity	Beta	+50	+337	-420
	Alpha	-330	-27	+136
	Change in No. Nonspecific GSR 1st to last 5'	+3.4	-14.8	-17.0
Release of Endogenous Adrenaline	Post-Expt. Level (μg/hr.)	1.21	1.56	0.45
	Adr. % in Total	44%	41%	26%

FIGURE 7

This figure shows the relationship of peripheral vascular activity (plethysmographic alpha waves) to nonspecific skin resistance fluctuations and adrenaline levels.

The differences between low vascular activity (0-80) and high (121) were significant at better than .05 level.

DETERMINANTS OF VASCULAR ACTIVITY



76.5	87	154
0.86	1.31	1.53
31%	36%	42%
0-80	81-120	121+
N=10	N=13	N=9

II. DIFFERENTIAL PSYCHOPHYSIOLOGICAL CORRELATES OF BODY AND FIELD PERCEPTUAL MODE

The results mentioned in the previous section indicated that subjects who rely more on external rather than internal cues react differently to an experience in which external cues are lacking than those who rely more on internal cues.

Field dependent subjects performed more poorly on pre and post-experimental two point discrimination and letter identification, remained more aroused and tended to move around more than did body subjects. Post-experimentally they expressed more discomfort about the experiment, struggled more with feelings and fantasies, or denied them and were more suspicious and projected internal percepts more.

There is some evidence that suggests that the differences in body and field subjects may not only represent a differential responsibility to a specific experimental environment but may reflect some individual differences in these two groups.

Witkin had noted that the two groups differed psychologically with the field oriented subjects being more "outer" directed (Reisman) in that they showed more concern with conforming to the values of others and less comfort acting on the basis of their own values and impulses. Furthermore, the perceptual mode was related to other personality characteristics with field dependent persons demonstrating more passivity in dealing with the environment, more submissiveness to authority; lower self esteem and a less distinct body image.

Some of the fundamental questions raised by Witkin in his study were:

1. What is the relation between an individual's characteristic way of perceiving

and the general personality organization?

2. Is a subject's dependence on the outer field [illegible] perception associated with dependence on the external environment in general?

The psychological test characteristics (personality correlates) of the body and field subjects who were tested at this laboratory were studied to establish if a specific grouping of psychological characteristics could be identified for each group as Witkin had previously reported. Witkin reported differences in body and field subjects' response to a projective psychological test (the T.A.T.). He found that one characteristic which distinguished body and field subjects was the extent of self assertiveness in the principal character of the story in coping with his conflicts and with the environment. This particular characteristic was evaluated by a modification of the T.A.T. used at this laboratory (F.T.T.).

Subjects with the highest field rating had the lowest F.T.T. scores (high anxiety, low aggression). Subjects with the highest body rating had the highest F.T.T. scores. Hence, the F.T.T. score appeared to differentiate subjects with body and field ratings.

Although, the findings can only be considered suggestive, it is interesting that the F.T.T. does seem to discriminate the subjects. This is consistent with the findings of Witkin that field oriented subjects are not only unfamiliar and perhaps uncomfortable with their own internal percepts, but they lack awareness of their inner lives and fear their own impulses. Hence, in a test which requires the subjects to utilize fantasies and project these in stories told to a series of pictures the field oriented subjects show more evidence of anxiety than the body subjects.

The higher anxiety shown by the field subjects on the test protocols was paralleled by the adrenaline and noradrenaline levels in the urine specimen collected following the period when the projective test was taken. The subjects with field ratings had the highest percentage of adrenaline in their urines. Hence, there is endocrinological as well as psychological evidence that the field subjects demonstrated greater anxiety.

There was no clear cut correlation between the Taylor A and the body and field ratings, but there was a suggestive trend that body oriented subjects had lower Taylor Anxiety scores than field oriented. Furthermore, the evidence suggested that the field subjects with high adrenaline percentage and a low F.T.T. score had the highest Taylor A scores while the body subjects (with the low adrenaline per cent and the high F.T.T. scores had the lowest Taylor A scores.)

Witkin mentions that field subjects showed more evidence of repression (particularly of body feelings). MMPI repression scores suggested that field oriented subjects had the highest repression scores.

Only a portion of the extensive psychologic battery which has been administered to over 200 subjects has been analyzed to the point where inter-test correlations can be carried out. In the review of the psychological data the first aim is to identify the presence or absence of certain psychological characteristics described by Wikin.

The following predictions were made on the basis of Witkin's previous work. Cn the F.T.T., it was anticipated that body subject would have high aggression scores and field subjects, low aggression scores. Cn the Taylor A scale of the MMPI, it was predicted that body subjects would have low anxiety ratings, low

repression, low hypochendriasis and high ego strength. On the characterologic questionnaire a group of questions were scored for the type of expression of aggressive behavior and impulses; the extra or intrapunitiveness in the direction of aggression, and the degree of projection demonstrated by the subject. It was predicted that body subjects would show high aggression scores and demonstrate extrapunitive and projective characteristics (the projective characteristics should not be confused with the projection noted in the isolation studies. Projection refers to the handling of inferiority feelings as suggested by Witkin).

The data to date suggests that Witkin's findings or the personality correlates of body and field subjects is also present in this group. However, it is to be pointed out that the data reduction is not complete and more definitive conclusions will have to await further reduction of data.

The first section described the findings when the difference in response to low sensory input environments of body and field oriented subjects were reviewed. In this section psychological correlates of body and field perceptual modes have been mentioned. The data is also being reviewed to establish the relationship or influence of other individual psychological variables on response patterns to experimental stress.

The scores on the Taylor A scale were compared to subjects response to experiment.

Twenty-nine subjects of the thirty-five subjects had also been tested with the Taylor Anxiety Scale as well as having their perceptual modes evaluated. This section will merely indicate some of the preliminary findings regarding the relationship of the Taylor Anxiety scores, body and field perceptual mode and

the responses of the subjects.

There was no clear cut relationship Taylor Anxiety scores and body and field ratings, however, there was a trend for subjects with high Taylor Anxiety scores to display more field characteristics than subjects with low anxiety scores (8 of 15) field oriented subjects and (4 of 15) body oriented subjects had high Taylor Anxiety scores.

Preliminary correlation of the EEG and skin resistance data with a psychological grouping of the subjects using both the Taylor Anxiety and Perceptual Mode rating suggests that subjects with low Taylor Anxiety scores who are body oriented show less evidence of nervous system activation during the experiment than field oriented subjects with high Taylor Anxiety scores. It would appear then that a psychological dimension consisting of a combination of Taylor Anxiety score rating and body and field rating evaluated pre-experimentally might be predictive of the level of central nervous system arousal which would occur when a subject is exposed to two hours of low sensory input.

Another area of interest has been to investigate differences in endocrinologic and physiologic activity in the resting state as well as in a stimulated state are present in the two groups. The preceding section described the differences in the reactions of body and field oriented individuals to a specific kind of experimental environment. That section specifically referred to various physiologic, endocrinologic and psychologic reactions. However, it is difficult to know whether the differences which were noted were a result of the fact that body and field oriented individuals reacted differently to their perceptions or whether even before exposure to the specific experimental situation, there were characteristic differences

such as catechol amine excretory rates and vascular characteristics.

Body subject tended to have elevated catechol amines in spite of concomitant lowered G.S.R. Body subjects tended to have greater basal skin resistance variability and pulse rate variability. The body group, is thus similar physiologically as well as behaviorally to Lacey's "Cardiac Labiles". Lacey found that cardiac labile subjects (who he felt showed more intense bursts of sympathetic activity) had psychological characteristics similar to body subjects. Body subjects tend to reveal a negative relationship between catechol amines and G.S.R. while field subjects reveal the opposite. Similar trends are suggested with alpha waves on the plethysmograph. The field subjects had a greater mean number of non-specific G.S.R. and higher level of respiration rate variability.

The field subjects demonstrated considerable central nervous system and peripheral sympathetic activation but did not display impressive evidence of adrenal medullary responsivity during the experimental stress situation. This suggested that the activation of central nervous system may have been associated with active inhibition of or sluggish sympathetic compensatory reflex activity which was associated with a deficiency of neurohormonal substances (at least as far as the levels noted in the urine were concerned). However, the evidence was very unclear whether the responsible factor for the low levels was adrenal medullary secretion or some factor affecting the release of the substance from the neural endings.

Hence, there is some suggestion that the individual differences reflected in the body and field perceptual dimension may not only be related to the response to an environment which exaggerates these differences and leads to more arousal in one

group, but it may also reflect differences in neurohumoral (noradrenaline) and physiologic variables which are either a function of body and field differences or a parallel expression of some underlying central nervous system difference between the two groups.

III. THE INFLUENCE OF DRUGS AFFECTING CENTRAL NERVOUS SYSTEM ON BODY AND FIELD SUBJECTS RESPONSE TO LOW SENSORY INPUT CONDITIONS

As described in previous sections of this report, body oriented subjects after two hours in low sensory input environment showed less central nervous system arousal, less psychological distress and less of a decrease in sensory motor integration than field oriented subjects. Fifteen body and fifteen field oriented subjects were then tested in another experiment after a sedative, a stimulant and a placebo had been administered in an attempt to determine the effects of changes in the subject's central "excitatory state" on the previous response pattern given these two groups to the experimental conditions.

The expectation was that an increase in alertness and attention to external events in body oriented subjects produced by a stimulant might alter their psychological adaptational pattern, as well as their levels of C.N.S. arousal. The field oriented subject, who previously had shown high levels of central nervous system arousal, had focused their attention on the immediate environment. The administration of a sedative was expected to decrease the level of C.N.S. arousal which might be accompanied by diminished level of attention to immediate external situation and a decrease in discomfort. One major question that was tested, then, was whether the amount of arousal in a body oriented group given a stimulant drug would be less than a fiel oriented group given a sedative and what differences in psychological response accompany the administration of drugs?

A 3 x2 design was used with five subjects in each of six subgroups. The design lends itself nicely to an analysis of variance. The experimental design was identical

to that employed previously except that a capsule was placed in the subject's mouth just prior to experimenter leaving the subject in isolation.

The EEG and skin resistance data indicated that field subjects given a placebo showed more central nervous system activation than the body subject given a placebo. This was similar to findings of previous study when body and field subjects were tested in low sensory input experiment without drugs.

The field subjects showed a more pronounced decrease in C.N.S. activation when a sedative was given than the body subjects ($t = 3.53$ $p = .005$). In fact some of the body oriented subjects were alerted after administration of a sedative.

The most striking difference in the two groups was noted in the subjects who received a stimulant. Body subjects showed evidence of progressively increased activation throughout the two hour experiment. Field subjects showed evidence of a progressive decrease in activation following the stimulant drugs (Difference in change in body and field $t = 3.97$ $p = .005$).

Intra group comparison in the body group revealed that stimulants caused an increase and sedative a decrease in C.N.S. activation as compared to the placebo condition. However, in the field oriented group the placebo condition was associated with the most intense activation while the stimulant and sedative conditions were associated with a decrease in activation (the sedative field group had the largest decrease in C.N.S. activity) (Figure 8).

The differential responsivity of the body and field group was further highlighted by the cardiovascular and respiratory activity and catechol amine levels.

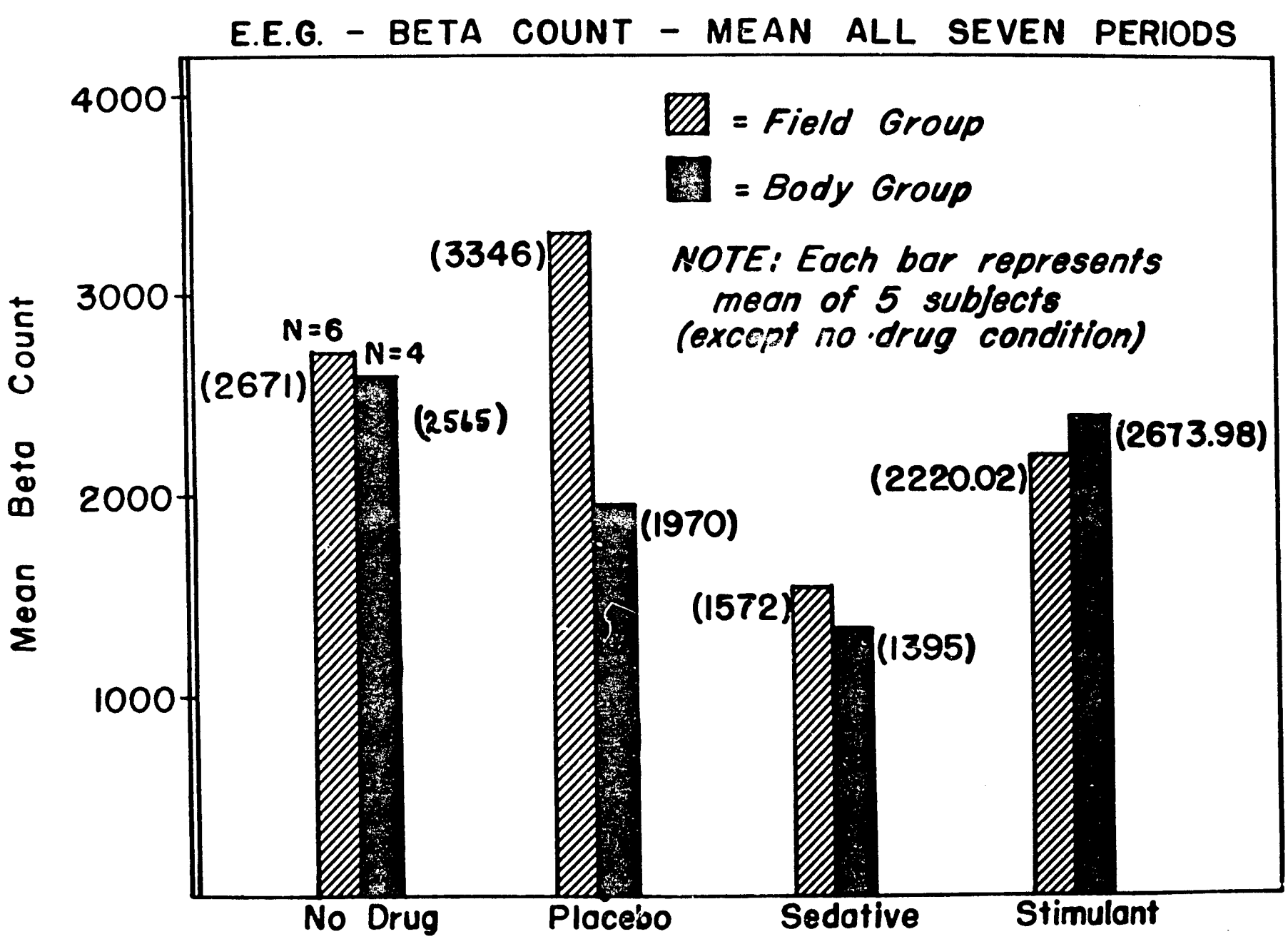
The differences in body and field subjects' response to sedative and stimulant drugs may be related to a difference in the psychological response of the subjects,

secondary to the effects of the drug or it may be associated with some effect on central nervous system and perceptual structures. Further, work in this area is required to identify the determinant of the response difference.

FIGURE 8

This figure shows the mean number of Beta waves (for a 5' period) in body and field subjects in the three drug conditions. (The mean Beta wave of ten subjects from earlier experiment where no drugs were given is also shown).

The figures on this chart indicate the mean Beta waves for all two hours (The Beta count to a large extent can be taken to reflect alert or activated brain functioning). It does not indicate change in Beta count from onset to end of experiment which is discussed in section III.


E.E.G. - BETA COUNT - MEAN ALL SEVEN PERIODS
Mean Beta Count
4000
3000
2000
1000
= Field Group
= Body Group
NOTE: Each bar represents mean of 5 subjects (except no drug condition)
N=6
N=4
(2671)
(2565)
(3346)
(1970)
(1572)
(1395)
(2220.02)
(2673.98)
No Drug
Placebo
Sedative
Stimulant

IV. PSYCHOCHEMICAL AND SENSORY DEPRIVATION

In a pilot study, the responses of subjects placed in a two hour low sensory input situation who were given a LSD capsule were compared to responses of subjects given a placebo.

The findings suggested that LSD subjects had a higher level of "arousal" (as assessed by EEG, basal skin resistance and number of skin resistance fluctuations) than control subjects. However, care must be taken in interpreting these findings because of the small number of subjects and the possible influence of individual personality and environmental (low sensory input) factors, as well as, the drug effect on the response differences noted in the two groups.

The LSD subjects, in contrast to the control group, experienced more vivid and sharper visual imagery during isolation. Their behavior, however, was not noticeably different until 15-30 minutes after the termination of the two hour isolation period.

It is tentatively postulated that the imagery experienced in the chamber is secondary to a direct neurophysiological effect of the drug and that the more intense perceptual, emotional and behavioral disturbance noted 1/2 - 1 hour after the experiment in external sensory input and inter-personal interactions.

There appears to be certain parallels between the changes exhibited after LSD and those seen with sensory deprivation (although the interaction of the two conditions may result in a different effect). The low sensory input environment may represent a threat to some individuals. The "threat" may be secondary to a sensory stimulus "hunger" with the associated exaggeration of visual phenomena

(such as phosphenes). The LSD subject may also be more sensitive to visual phenomena because of neurophysiological alteration.

Elkes has suggested that some of the psychological effects of LSD are secondary to changes to the quality and quantity of sensory input. Evarts reported LSD had a blocking effect on the visual pathways that could be responsible for altered visual perception noted in many subjects given LSD including those in this pilot study.

Very slight differences were noted in the isolation period when minimal stimuli were perceived in the chamber but rather noticeable perceptual and psychological differences were noted after the two hours of isolation when the subjects were exposed to environmental sensory cues. This suggest that the effects of LSD were mainly affecting the perceptual abilities of subjects (as suggested by Elkes and others). However, the LSD in contrast to the placebo group did show a few differences during isolation such as the evidence of slightly higher level of C.N.S. alerting and more imagery. The imagery appeared to be an elaboration of minimal auditory and visual cues occurring during the experiment. Hence, a psychochemical drug believed to affect central integrative functions (probably perception) produced reaction patterns similar to that of field oriented subject.

TABLE 2

This table lists the LSD and control subjects from the most to lea "activated" on the basis of the change in Basal Skin resistance during t. e two hour experiment. (Subjects with decrease or small increase in basal resistance are rated as most activated). The mean number of nonspecific G.S.R. fluctuations and post-experimental adrenaline levels are also shown.

TABLE 2

*Subject	Group	Change in Basal Resistance Onset to End of Experiment	Mean Number of Nonspecific G.S.R. Per 5' Period	Post-Experimental Adrenaline Level In Micrograms Per Hour (and Change From Resting Levels)
		Most Activation		
LN	LSD	-1000 ohms	17	3.14 (+1.89)
TJ	Control	+1700 ohms	16	3.67 (+0.74)
DP	LSD	+2500 ohms	16	2.56 (+1.32)
FP	LSD	+4800 ohms	15	1.48 (0.57)
BG	LSD	+5000 ohms	9	---------
		Least Activation		
LT	Control	+12,500	0.6	1.11 (+0.93)
DD	Control	+15,000	6.6	4.52 (+2.72)
SC	Control	+17,300	1.0	1.17 (-0.45)
**BL	LSD	+31,500	1.4	0.94 (-1.07)

*Data on one control subject was incomplete.

**This LSD subject had been a volunteer in a previous Sensory Deprivation experiment.

VI. A ACTIVITIES
(November 1960-June 1961)

November 1960

Dr. Shmavonian attended The Pavlonian Conference for Higher Nervous System Activity. Joint program of New York Academy of Science and Soviet Academy.

Dr. Silverman attended the meeting of the Group for Advancement of Psychiatry in Asbury Park, New Jersey where discussions were held regarding the research of the Duke Group.

December 25-29, 1960

Dr. Cohen consulted with members of the Department of Psychology, University of Miami, Miami, Florida regarding their efforts to initiate sensory deprivation studies.

February 27-29, 1961

Dr. Neil Burch and Mr. H. Childers of Baylor University visited the laboratory to consult in regard to bioelectric equipment.

Dr. Silverman was guest lecturer to the Strecker Psychiatric Society, University of Pennsylvania.

March, 1961

Dr. Shmavonian attended a meeting of The Eastern Psychological Association in New York.

April 12-14, 1961

Dr. S. Cohen presented a paper at the Annual Meeting of Southeastern Psychological Association "Research problems in behavioral pharmacology".

Dr. Silverman attended the meeting of the Group for Advancement of Psychiatry in Asbury Park, New Jersey. Research discussions were held with Drs. G. Ruff, James Miller, C. Shagass, N. Calloway.

May, 1961

Dr. R. Malmo of McGill University, Montreal, Canada visited the laboratory to discuss problems of bioelectrical measures of physiological activity.

Dr. J. Reckless presented a paper to the Residents Research Symposium sponsored by the North Carolina Neuropsychiatric Society reviewing the work he had done during his research fellowship of the laboratory, drugs, body and field perception and sensory deprivation". (He was awarded 1 st. prize for his presentation).

Dr. George Engel of the University of Rochester School of Medicine visited the laboratory to review the activities of the laboratory and discuss psychophysiological research.

June, 1961

Drs. Cohen and Silverman attended the World Congress of Psychiatry, Montreal, Canada. Dr. Silverman was a participant in a panel discussion devoted to sensory deprivation. Dr. Cohen was a participant on a panel devoted to experimental psychopathology. Dr. Cohen also presented a paper, Neurophysiological, humoral and personality factors in the response to sensory deprivation.

Dr. J. Benjamin of University of Colorado Medical Center visited the laboratory for research discussions.

VI. B. PUBLICATIONS
(November 1960-June 1961)

1. Cohen, S.I., Silverman, A.J. and Shmavonian, B.M. The influence of psychodynamic factors on central nervous system functioning in young and aged subjects. Psychosom. Med. Vol. 23: 2, March-April, 1961.

2. Silverman, A.J., Cohen, S.I., Shmavonian, B.M. and Greenberg, C. Psychophysiologic investigations in sensory deprivation: The body/field dimension. Presented at meeting of Am. Psychosom. Society, March, 1960. Psychosom. Med. Vol. 23: 2, Jan-Feb., 1961.

3. Cohen, S.I., Silverman, A.J., Waddell, W. and Zuidema, G. Urinary catechol amine levels, gastric secretion and specific psychological factors in ulcer and nonulcer patients. J. Psychosom. Res. Vol. 5: 2, pp. 90-115, 1961.

4. Silverman, A.J., Cohen, S.I., Shmavonian, B.M. and Kirshner, N. Catechol amines in psychophysiologic research. Recent advances in biological psychiatry, 1961.

5. Cohen, S.I., Silverman, A.J. and Shmavonian, B.M. Experimental stress in the study of psychopathological and neuroendocrinological relationships. A Survey of human psychopathology. (Ed. L.J. West), Paul Hoeber and Company (In press).

6. Cohen, S.I., Silverman, A.J. and Shmavonian, B.M. Neurophysiological humoral and personality factors in the response to sensory deprivation. Proceedings of Third World Congress. (Ed. R. Cleghorn), (In press).

7. Cohen, S.I., Silverman, A.J., Bressler, B. and Shmavonian, B.M. Problems in isolation studies. Chapt. 8 in Sensory Deprivation. (Ed. by P. Solomon, P. Kubzansky, Leiderman, J.H. Mendelson, R. Trumbull, and D. Wexler. Harvard University Press, Cambridge, Mass., 1961.

8. Silverman, A.J., Cohen, S.I., Shmavonian, B.M. and Bressler, B. Hallucinations in sensory deprivation. Chapt. in Hallucinations. (Ed. L.J. West) Grune & Stratton, New York. (In press).

VI. C. ADDITIONS TO STAFF

January 1961

Dr. E. McGough, Instructor in Psychiatry, joined the laboratory staff on a part time basis in order to participate in research activities with the staff.

February 1961

Mr. A. Yarmat joined the laboratory staff as a pre-doctoral research fellow on a full time basis.

Mrs. Connie Durrett joined the laboratory on a full time basis as a research technician.

June 1961

Mr. A. Lowery, an electrical engineer, began work on a consultative basis with the laboratory staff regarding development of maintenance problems in bioelectronics.

Dr. L. Graham, a senior resident in psychiatry, joined the laboratory staff as a senior research fellow.